Slide 1

The National Airspace System (NAS) architecture is an evolutionary plan for modernizing the NAS and moving towards Free Flight. The architecture incorporates new technologies, procedures, and concepts to meet the needs of NAS users and service providers.

The NAS architecture is the result of intense Federal Aviation Administration (FAA) and aviation industry involvement in capturing and restructuring the requirements for a modernized, safer, and more efficient NAS. The NAS architecture describes the system support, operational concepts, schedules, human and physical resources, and other actions essential for maintaining NAS safety, capacity, and performance.

The modernized NAS will offer greater flexibility and functionality through systems that are based on up-to-date technology, information sharing, and common data exchange evolving over time. However, during this evolution, the NAS must be sustained to operate without interruptions.

The FAA's Strategic Plan sets the following long-term mission goals for aerospace:
Safety: By 2007, reduce U.S. aviation fatal accident raters by 80 percent from 1996 levels
Security: Prevent security incidents in the aviation system
System Efficiency: Provide an aerospace transportation system that meets the needs of users and is efficient in the application of FAA and aerospace resources.

The National Airspace System architecture resource priorities are:
Sustain current NAS services and the facilities necessary to deliver these services while ensuring Safety
Support safety initiatives that improve current safety services and reduce accident and incident rates as traffic grows
Deploy security measures to reduce risk to the travelling public and our workforce
Add new capabilities to improve efficiency, capacity, access, predictability, and flexibility in delivery of services

Slide 2

Architecture Characteristics

- Definition – The highest level concept of a system in its environment
- Architectural Description
  - A model, document, database or other product that communicates and records a system’s architecture
  - Conveys a set of views that depict the system through varying perspectives/concerns
  - Subject to standardization
- Purpose of an Architecture
  - Allows the system to be placed under control
  - Aids in the clarification of requirements and assessment of impact on system design

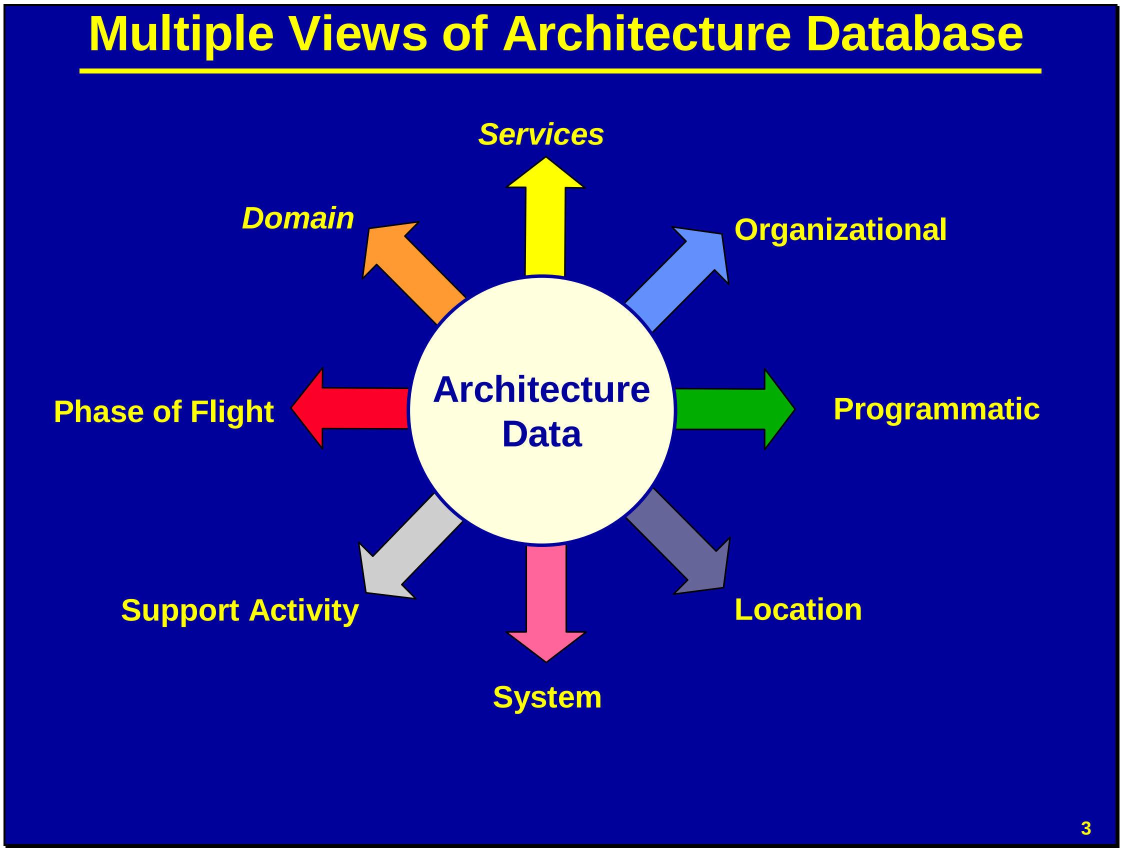
2

The FAA, together with the aviation community, has developed the NAS architecture, the long-range plan to modernize the NAS. The NAS architecture is a 15-year strategic plan that reflects the fundamental organization of the NAS and includes all existing and planned capital investments, their relationships to each other and the environment, and the principles governing their design and evolution.

The NAS architecture encompasses the replacement of aging equipment and the introduction of new systems, technologies, and procedures that enhance safety and security and support future aviation growth. It provides an integrated view of new systems, airspace changes, procedures, training, avionics (equipment in the aircraft itself), and rulemaking. The NAS architecture takes the FAA plans and integrates these into the delivery of FAA services and capabilities.

NAS architecture data is divided into programmatic components (e.g., costs and schedules) and technical components (e.g., concepts, services, capabilities, implementation steps, requirements, and enabling mechanisms) that are combined to meet the FAA mission and to deliver desired aviation services to the aviation community and aviation service providers.

Slide 3



There are multiple ways to view the NAS architecture, which can be described in terms of a hierarchy as noted below:
Service Groups: a collection of related services. There are six Service Groups used in the NAS architecture:
Air Traffic Services
Airport Management Services
Certification Services
Business Management Services
Safety Services
Security Services
Services: High-Level activities, performed by the FAA for the aviation community that contribute to the flow of aircraft throughout the NAS
Capabilities: A set of functions or related activities that enables or supports the delivery of a service
Implementation Steps: The ***mechanisms*** and ***operational scenarios*** necessary to enable the delivery of a capability.

Mechanisms are the enabling people, support activities, and systems necessary to meet the FAA's mission and to deliver desired aviation services to the aviation community. Support activities include procedures development, training, airspace design, certification, standards, and rulemaking. ***Mechanisms*** together with ***operational scenarios***, define Implementation Steps. Implementation Steps, and their schedules, for each Capability detail the evolutional plan for the Capability.

This is the "service" view of the NAS architecture. "Domain" views (communications, navigation, etc.) are used later in this briefing to describe the FAA's plans to evolve the NAS.

Slide 4

Collaboration

- Partners
  - RTCA, Inc
  - International Civil Aviation Organization (ICAO)
  - National Transportation Safety Board
  - National Aeronautics and Space Administration (NASA)
  - Department of Defense
  - Industry
  - Manufacturers
  - Employee Unions
  - Civil Aviation Authorities

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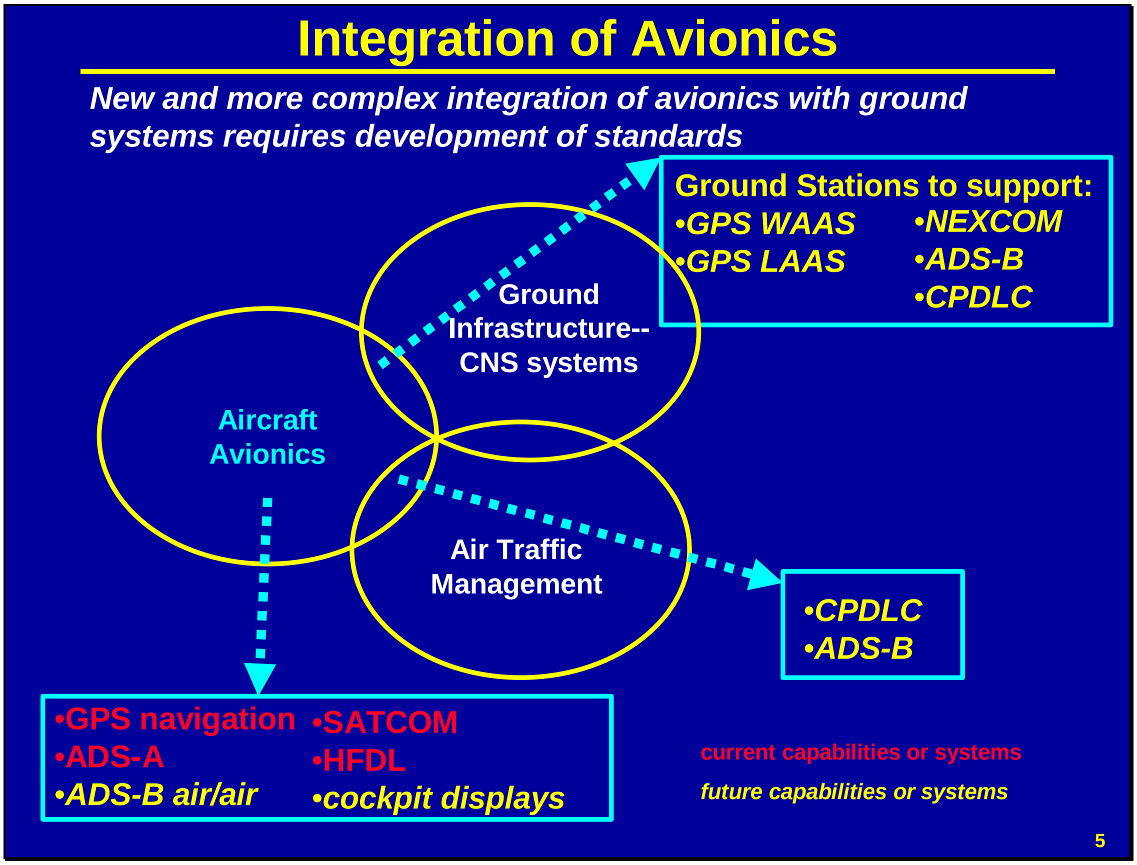
In addition to collaboration among the various FAA lines of business, the FAA works with partners in the aviation community to improve the NAS architecture. The aviation community contributes to the NAS through government/industry forums, architecture working groups, and many other arenas.

NAS users and customers include air carriers, air cargo, commuter air carriers, air taxis, general aviation, the military, and state, local and other Federal government entities. They all provide valuable input regarding the NAS architecture from a customer needs perspective.

The architecture plans the evolution of the NAS, including the replacement of aging equipment and the introduction of new systems, capabilities, and procedures. The architecture provides a roadmap to increased benefits to all users while increasing safety through new technologies, procedures, and the collaboration among users and service providers. The NAS architecture facilitates continuing dialog on modernization between the FAA and the aviation community.

Slide 5



New technologies and more complex integration of avionics with ground systems require development of new standards.

Currently, standards and certifications for avionics are in place that support GNSS navigation, Automatic Dependent Surveillance - Addressed, SATCOM (satellite communications), and HFDL (high frequency data link). Standards are being developed for Automatic Dependent Surveillance - Broadcast (ADS-B), precision approaches supported by GNSS augmentation systems (i.e., Wide Area Augmentation System, WAAS), NEXCOM (next generation communications system, VDL Mode 3), and CPDLC (Controller/Pilot Data Link Communications). These standards support avionics interface with CNS ground systems and ATM ground systems.

The FAA's National Airspace System architecture evolves as users determine what capabilities/avionics to install, operational validations successfully complete, new technologies emerge, and standards are developed.

Slide 6

Communications Highlights

Improving quality and capability with digital VHF communications - UHF & HF analog air-ground communications sustained as required

Phase 1 (1998 - 2002)

- **Award VDL Mode 3 (NEXCOM) multi-mode radio production contract, 2001**
- **Initial CPDLC message set (Build 1) implemented via VDL Mode 2**

Phase 2 (2003 - 2007)

- **Begin installing digital VHF (data link-capable) VDL Mode 3 radios**
- **Conduct VDL Mode 3 digital voice system tests and operational demonstrations (with airlines)**
- **National deployment of CPDLC Build 1A**

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In the following charts, the architecture domain is identified, the modernization objective for the domain stated, and the specific actions within the three phases of modernization are explained.

Radio Spectrum a Limiting Resource - Available spectrum is the limiting resource for growth in U.S. air transportation. Increasing pressure on available spectrum requires the FAA to invest in digital technology to recover spectrum for further use.

The next generation air-ground communications (**NEXCOM**) program began in 1998. The FAA awarded the NEXCOM multi-mode digital radio production contract in 2001. The radio will be capable of operating in either the digital mode or the analog mode. Initially, the radio will be deployed and used in the analog mode. A NEXCOM system prototype and demonstration validation effort will be conducted beginning in 2002, leading up to a NEXCOM system development contract award in 2005. The NEXCOM radios will operate in analog mode until 2008 when high-altitude airspace will be converted to digital communications, provided that all the aircraft using the airspace are equipped with a compatible digital radio. This conversion to digital radios will free up VHF spectrum to meet other analog air-ground service requirements. The existing analog air-ground communications system will be maintained and augmented as necessary while NEXCOM radio implementation proceeds.

The FAA has begun transitioning voice communications to data link communications as a means to reduce congestion on voice channels. Data link communications between ground facilities and aircraft will include air traffic control, weather, and aeronautical information. The FAA is currently implementing an operational Controller/Pilot Data Link Communications (**CPDLC**) Build 1 capability at the Miami Center. Build 1 will implement the message services required to perform transfer of communications, initial contact with the controller, altimeter settings, and pre-defined text messages. These messages will be sent via the service provider’s VHF digital radio. Build 1A expands to nine messages.

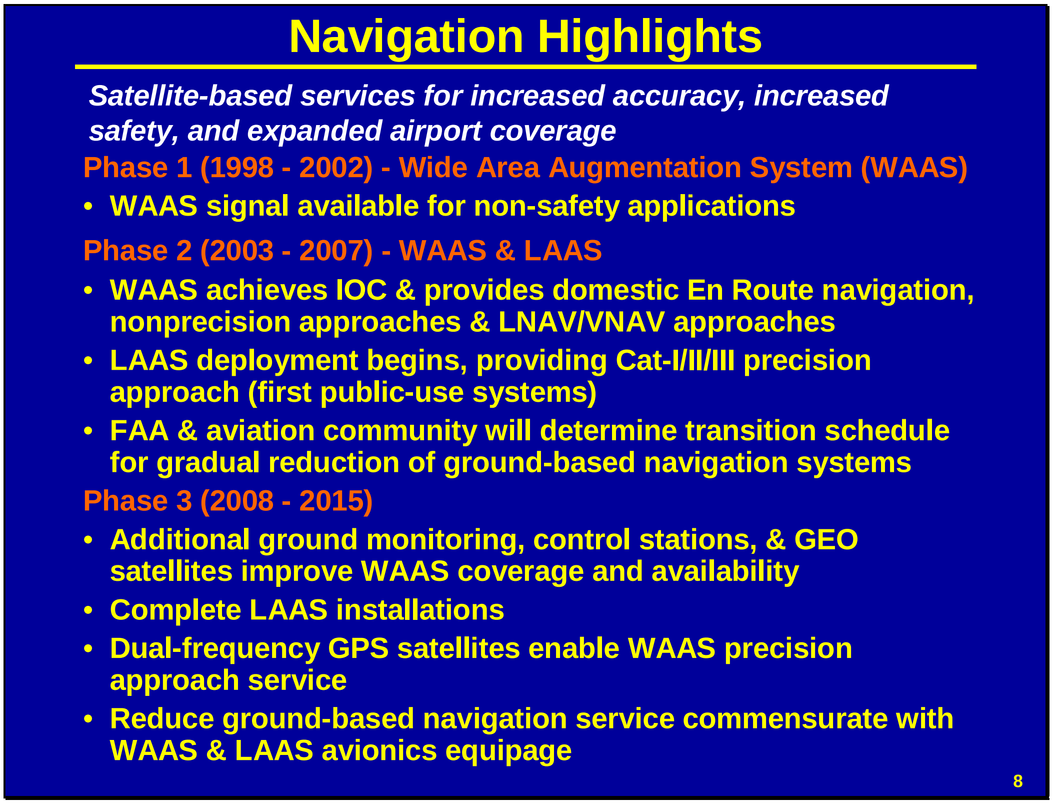
Slide 7

Communications Highlights (cont.)

Phase 3 (2008 - 2015)

- **2008: Begin VDL Mode 3 voice communications in super high and high en route sectors**
- **2010: Begin VDL Mode 3 data communications in super high and high en route sectors**
- **VHF analog voice service remains available in many low density areas**

Slide 8



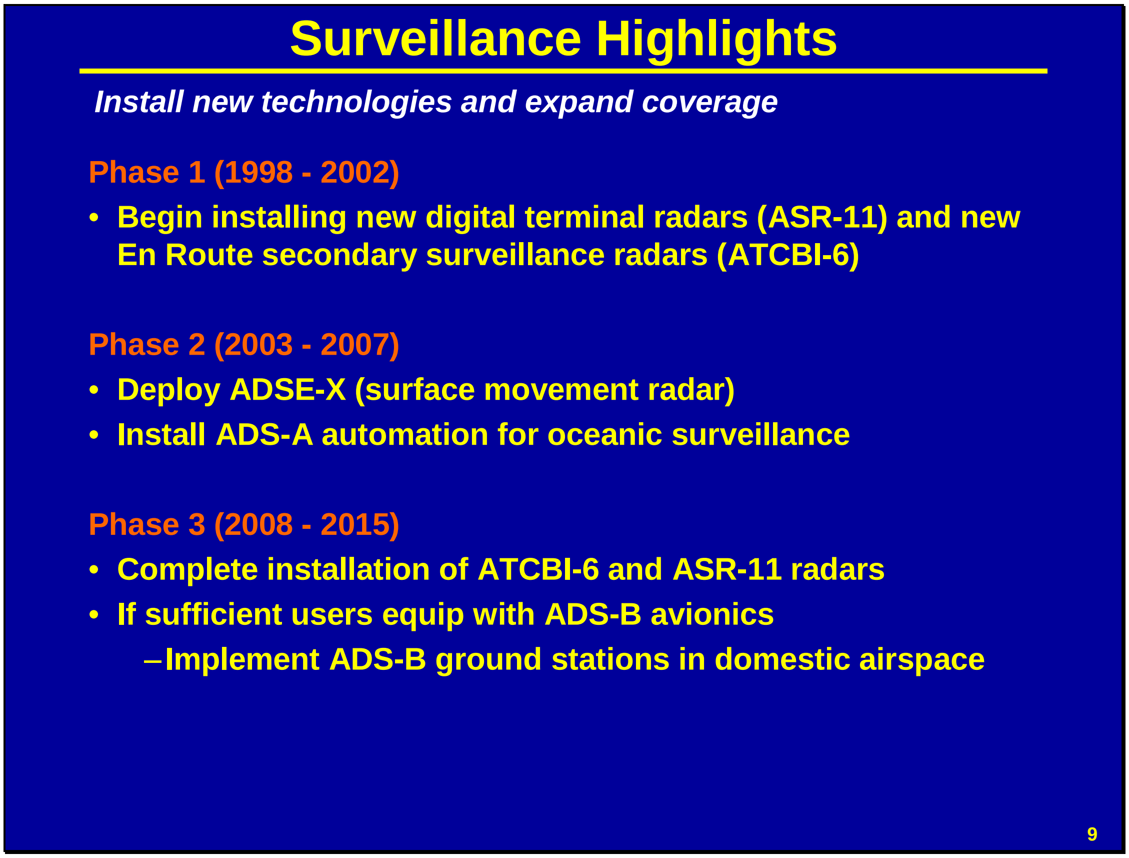
Satellite-based navigation, augmented by WAAS and LAAS systems, will meet the demand for additional navigation and landing capabilities and improve safety while avoiding the cost of replacing, expanding, and maintaining many of today's ground-based navaids. The development of WAAS and LAAS systems will provide the basis for NAS-wide direct routing, provide guidance signals for precision approaches to most runways in the NAS, and reduce the variety of navigation avionics required aboard aircraft. Operational efficiency and safety will be improved by adding thousands of precision and non-precision approaches at many airports lacking such capabilities today. This increased availability of instrument approaches will alleviate one of the major safety concerns - controlled flight into terrain.

Wide Area Augmentation System - Ground stations and communications satellites that provide wide area coverage and deliver information on accuracy, integrity, and improvements on availability for the global positioning system.
Local Area Augmentation System - provides precise correction data to airborne and surface receivers, and supports precision instrument landings. Coverage extends to 20 miles or more from the airport.
Initially, WAAS will provide the Lateral Navigation/Vertical Navigation (LNAV/VNAV) approach and landing as an initial operational capability (IOC). Additional WAAS Master Stations, WAAS Reference Stations, and Geo-stationary Satellites (GEOs) will become operational, increasing the initial service volume. The hardware installed earlier in the program will be upgraded to the current standard. The L5 civil signal from GPS will enable WAAS to provide Category I precision approach service throughout the NAS.

LAAS will complement the WAAS and function together to supply users of the NAS with seamless satellite-based navigation for all phases of flight. LAAS will provide a precision instrument approach capability to all suitably equipped runways and aircraft. LAAS will meet the stringent Category II/III requirements that exist at selected airports throughout the US. LAAS will also be used at locations where the WAAS is unable to meet Category I landing requirements.

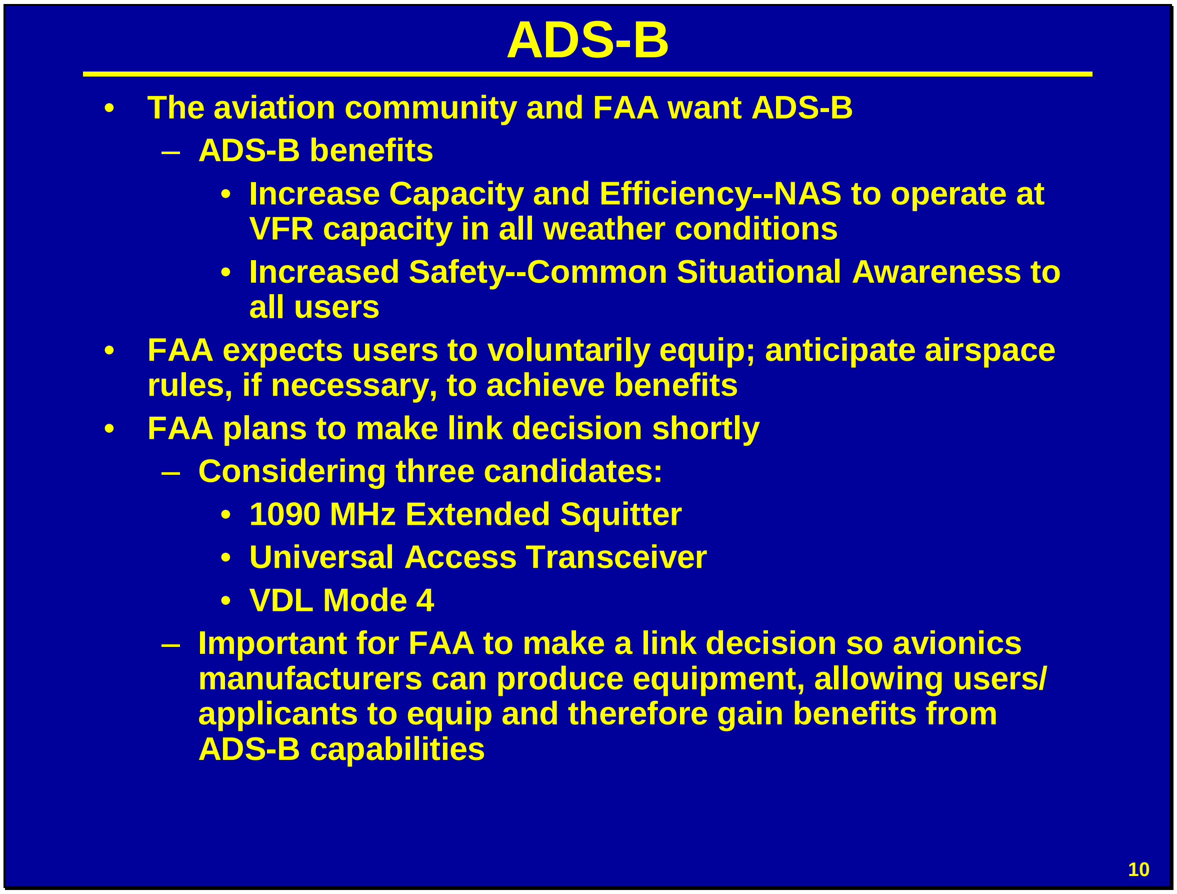
Aviation users (led by Air Transport Association, ATA, and Aircraft Owners and Pilots Association, AOPA) have formed a Satellite Navigation Users Group that will work with the FAA to help determine the schedule for the transition to satellite navigation and the reduction of service from our traditional ground-based navigation systems.

Slide 9



En Route - The current en route air traffic control beacon interrogator (ATCBI) radars will be replaced with new digital monopulse beacon radar, the ATCBI-6.
Terminal - ASR-11, which consists of a primary radar paired with a monopulse beacon radar, will provide improved aircraft and weather detection and aircraft tracking compared with the ASR-7/-8 and ATCBI-4/-5 radars it replaces, in a digital format needed for STARS (the new terminal automation system).
Surface - The ASDE-X consists of a primary surface radar subsystem, multilateration subsystem, surface surveillance data fusion, and a display. Commercial-off-the-shelf equipment will be acquired, if possible, with some development necessary for the surveillance data fusion function.

Slide 10



The reasons why the aviation community and the FAA are interested in Automatic Dependent Surveillance - Broadcast (ADS-B) are clear. Foremost, ADS-B is seen as a cornerstone enabler for free flight because it provides common situational awareness for more shared air and ground responsibility. ADS-B is expected to improve safety and to increase efficiency and capacity. Safety is increased with improved situational awareness. Efficiency is gained as the improved situational awareness and new procedures let pilots and controllers make better use of existing separation standards. Capacity will be further increased as confidence in ADS-B capabilities allows reduction of separation standards and new models of control responsibility. ADS-B intent information will also provide improved performance for decision support tools.

From a NAS architecture perspective, there is a key dependency on voluntary avionics equipage with ADS-B in order to provide the cost/benefit basis for National Implementation. A link decision based on the best available thinking and data about cost implications and intended early uses will stimulate user equipage at levels that support the architecture. The FAA plans to make a link decision shortly.

The FAA's Operational Evolution Plan includes two initiatives enabled by ADS-B:
Coordinate for Efficient Surface Movement—new tools for airport surface traffic management will provide airport personnel the capability to predict, plan, and advise surface aircraft movements.
Enhance Surface Situational Awareness—the Safe Flight 21 program is addressing cockpit-based tools to supplement existing visual navigation aids and controller communications in the pilot's attempts to accurately determine the aircraft's position on the airport surface.

The Safe Flight 21 program is also focusing on avionics technology like the Cockpit Display of Traffic Information (CDTI) that enables the pilot to electronically "see and avoid" other aircraft. The Alaskan Region's Capstone Program is an accelerated effort to improve aviation safety and efficiency through a series of operational demonstrations and evaluations by installing government-furnished, GPS-based avionics and data link communications in commercial aircraft. Use of ADS-B in a non-radar environment for separation became operational in January 2001 for air traffic control of Capstone-equipped aircraft.

Slide 11

Automation Highlights

Free Flight Phase 1: Deploying new capabilities to accelerate user benefits

Free Flight Phase 1 (1998 - 2002)

- **CDM - Information exchange with airline operations centers**
- **URET - Conflict probe for controllers**
- **TMA - Flight metering for en route controllers**
- **pFAST - Runway assignment and sequencing for controllers**
- **SMA - Enhanced aircraft information and information exchange for controllers and users**

Phase 1 (1998 - 2002) - Replace the Automation Infrastructure

- **En Route - DSR, HOCSR**
- **Terminal - Common ARTS, STARS**
- **Oceanic - Award ATOP contract**

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The evolution towards increased efficiency and flexibility under instrument flight rules requires significant improvements in en route, terminal, and oceanic automation systems and controller decision support tools.

From the RTCA Government/Industry Free Flight Action Plan, August 1996 - "Free Flight is defined as a safe and efficient operating capability under instrument flight rules in which the operators have the freedom to select their path and speed in real time. Air traffic restrictions are only imposed to ensure separation, to preclude exceeding airport capacity, to prevent unauthorized flight through special use airspace, and to ensure safety of flight. Restrictions are limited in extent and duration to correct the identified problem. Any activity which removes restrictions represents a move towards free flight."
To safely implement Free Flight in high-density airspace, new automation tools will be needed to help controllers deal with the additional complexity associated with the more variable mix of routes and crossing points. The tools are included in Free Flight Phase 1. CDM, URET, TMA, and SMA have been successfully implemented at several sites. The FAA determined that the cost of implementing pFAST exceeded the benefits that would be obtained; the FAA is considering other options to provide this benefit.

Additionally, the FAA is replacing the automation infrastructure in all domains - en route, terminal and oceanic.
DSR - Display System Replacement
HOCSR - Host and Oceanic Computer System Replacement
ARTS - Automated Radar Terminal System
STARS - Standard Terminal Automation Replacement System
ATOP - Advanced Technologies and Oceanic Procedures

Slide 12

Automation Highlights (cont.)

Phase 2 (2003 - 2007)

- **Terminal - Continue STARS installation**
- **En Route - Complete replacement of infrastructure - the En Route Communications Gateway and the En Route software**
- **Begin geographic expansion of FFP1 tools**
- **Oceanic - Replace infrastructure with ATOP**

Phase 3 (2008 - 2015)

- **Complete STARS installation**

Slide 13

Summary Comments

- **The NAS Architecture is the result of a joint aviation community/FAA effort**
- **Modernization of the ATC system is intended to increase efficiency and benefits for all users**
- **The actual evolution of the NAS Architecture will depend upon:**
  - **User decisions regarding avionics equipage**
  - **Availability of funding**
  - **The results from R&D projects like Safe Flight 21**
  - **The emergence of new technologies**
  - **The development of standards**

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The FAA and the aviation industry are collaborating on plans to modernize the NAS within fiscal guidelines. While the FAA's goals focus on safety, security, and improved efficiency, the core infrastructure used to deliver existing services must be sustained. Since the NAS architecture represents the longer overall view of NAS modernization, the architecture will continue to be the primary means of maintaining consensus on NAS modernization, preparing capital budgets, tracking requirements, and measuring progress in modernization. The architecture will be updated and used to drive decisions affecting delivery of services and capabilities in accordance with the Administration's priorities. With the addition of information from the operational evolution planning, and better estimating tools for operating costs, the NAS architecture will be able to project forward these operating costs to provide a better representation of future costs of services and delivery of capabilities.

Slide 14

FAA Web Sites

- Capability Architecture Tool Suite (CATS-I)
  - http://www.nas-architecture.faa.gov/cats/
- NAS Architecture
  - http://www.faa/gov/nasarchitecture
- Operational Evolution Plan
  - http://www.faa.gov/programs/oep
- Capital Investment Plan
  - http://www.faa.gov/asd/cip02/FY02cip.htm
- FAA homepage
  - http://www.faa.gov
- FAA's Strategic Plan
  - http://www.apo.data.faa.gov/dirplancs/docs/sp2001.html
- Aviation Capacity Enhancement Plan
  - http://www.faa.gov/ats/asc/ace.html
- Airport Capacity Benchmark Report
  - http://www.faa.gov/events/benchmarks/

This page lists several FAA web sites that provide overarching planning information.

The NAS architecture, the Operational Evolution Plan (OEP), and the Capital Investment Plan (CIP) are key NAS modernization plans. These plans are consistent and complement each other with increasing detail relating to execution of FAA commitments. These plans ensure a well-planned modernization effort that balances FAA resources to maximize aviation community benefits.

The NAS architecture is the aviation community's 15-year strategic plan for modernization, supporting safety, security, and efficiency goals. The NAS architecture is represented within the Capability Architecture Tool Suite (CATS-I).

The NAS Operational Evolution Plan (OEP) represents the agreement of the FAA, airport operators, and industry to provide capacity growth to meet the public's need for air transportation. This operationally oriented plan integrates and aligns FAA activities with those of industry. The evolution is based on existing plans and organized around specific capacity-demand problems: arrival/departure throughput at airports, en route congestion, en route severe weather, and severe weather conditions that regularly disrupt operations at key airports.

The NAS Capital Investment Plan (CIP) is the agency's 5-year capital investment plan linked to FAA performance goals--safety, security, and efficiency. The CIP ties together the financial investments necessary to realize the improved services and capabilities defined within the NAS architecture.

The architecture evolves as users determine what capabilities/avionics to install, operational validations successfully complete, new technologies emerge, and standards are developed.